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SCALE MODEL BAFFLE IMPEDANCE TESTS,(U)
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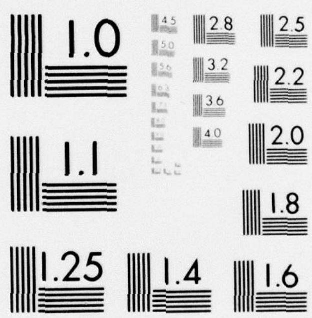

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SCALE MODEL BAFFLE IMPEDANCE TESTS (U)

by

10 I. E. Melnick

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11 Feb 67

Submitted to:

12 13p. U.S. Navy Electronics Laboratory
San Diego, California

Approved:

Walton Graham
Department Head, TRG

Approved:

Marvin Baldwin
Project Technical Director, NEL

Submitted by:

TRG, A Division of Control Data Corporation
Route 110
Melville, New York 11746

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SCALE MODEL BAFFLE IMPEDANCE TESTS

The accompanying photographic prints were reproduced from the acceleration records made of the response of various acoustic baffle models that were tested in the TRG Acoustic Test Chamber.

The initial object of the experiment was to obtain experimental data on the mechanical impedance of baffles proposed by TRG and G/D. The acoustic test chamber had already been used to obtain data in air which agreed with the experimentally determined behavior of the same baffle configuration in water. An analysis of scaling laws suggested that we could scale frequency and physical dimensions inversely.

The TRG proposed hull configuration consists of plating with sea chests and resonators.

Two sets of data for the G/D baffle are presented: a slotted aluminum block with cylindrical holes for transducers of 4-inch and 5-inch diameters.

Sets of data for 1/6 scale model tests and 1/4 scale model tests are presented. Historically, the 1/6 scale models were chosen first due to the ready availability of raw aluminum block of the necessary thickness for the G/D model. Later, thicker sections were found to be available and a 1/4 scale model was made. The availability of data from both scales allows further substantiation of the scaling laws being used.

The reference for the experiments is a steel plate of 3/4 inch full scale thickness, this being representative of existing hull plating near the keel of a large ship.

The data recorded in this experiment is the output voltage of an accelerometer mounted on the particular test piece. The test piece is accelerated by an acoustic wave

produced by a loud speaker. The accelerometer is mounted on the side of the test piece that is not insonified. A special effort is made to prevent the acoustic field from leaking around the joint between the test piece and the acoustic test chamber to minimize the pressure response of the accelerometer, which was found to be a problem. Accelerometers were first mounted on the insonified side to provide a greater number of possible accelerometer locations on the TRG models where the other surface was covered by sea chests and resonators. The requirements for reliable data required that freedom in the location of accelerometers be compromised. The solution was an accelerometer located on the non-insonified side of the brass plug which represented the transducer in the model. The two locations where accelerometer data were taken were prepared by cementing the simulated transducers to the hull structure. All other simulated transducers were isolated from the hull structure.

Data were taken on a point at the center of the model and near an edge to determine the uniformity of the plate response.

The loud speaker location within the test chamber was moved to give head-on insonification (normal incidence) and insonification at 45° to the plate (grazing incidence).

DATA ANALYSIS

Figure 1

The lower half of this plate shows the geometry of the test samples. The upper graph illustrates the effect of the pressure sensitivity of the accelerometer when the accelerometer was mounted in the test chamber (in acoustic field) and outside the test chamber (without acoustic field).

The lower graph is a check of accelerometer mounting technique. The red and green curves compare the response of the accelerometer when screwed in plate (a result of locating the accelerometer on the simulated transducer) with the response when cemented in plate (the usual procedure when mounting accelerometers on the insonified surface). The green and blue curves compare the response of two different accelerometers sequentially taken at the same location.

Figure 2

In this plate the acceleration response of the TRG hull model is compared to the response of a reference plate for the frequency band between 9 and 19 kc (full scale frequency range 1.5 to 3.16 kc). The length of the model's sea chests is scaled tc a full size length of 16 inches.

At grazing angles of incidence, a considerable reduction in plate acceleration is accomplished throughout the active sonar band, and below it.

A smaller effect is noticed in the data taken at normal incidence. Fortunately, a high hull impedance is not as necessary at this angle of incidence.

It is reasonable to expect that even lower accelerations will be recorded with larger sized test plates. This model is only one quarter of the size of the panel being proposed for the array.

Figure 3

This data compares the reference plate, the GD model with 5" holes (full scale), and the TRG model with 19 inch sea chests (full scale). Comparing the response of the 16 inch long sea chests from Plate 2, the longer sea chests result in a lowered impedance at the higher frequencies of the sonar band.

The data on the GD model suggests there are many modes of vibration throughout the sonar band. These 1/6 scale test results are worse in this respect than the 1/4 scale tests described later.

Figure 4

This 1/6 scale model test was performed on a block of aluminum slotted into the shape shown. Although it would seem that this plate would show a high impedance because of the large number of "resonators," the response was only slightly better than the reference plate. The mass, however, of the slotted block is 10 times that of the reference plate. It should then show a response 20 db below the reference plate. This is accomplished at only a few frequencies. A possible explanation for this effect is overcoupling through the basic "plate" between resonators.

Figure 5

Plate 5 shows the response of 1/4 scale models of the GD hull form with 4 inch diameter holes compared to a reference plate. The low frequency response is good, but the effectiveness of the design is limited to 11 kc on the scale model (2.75 kc, full size).

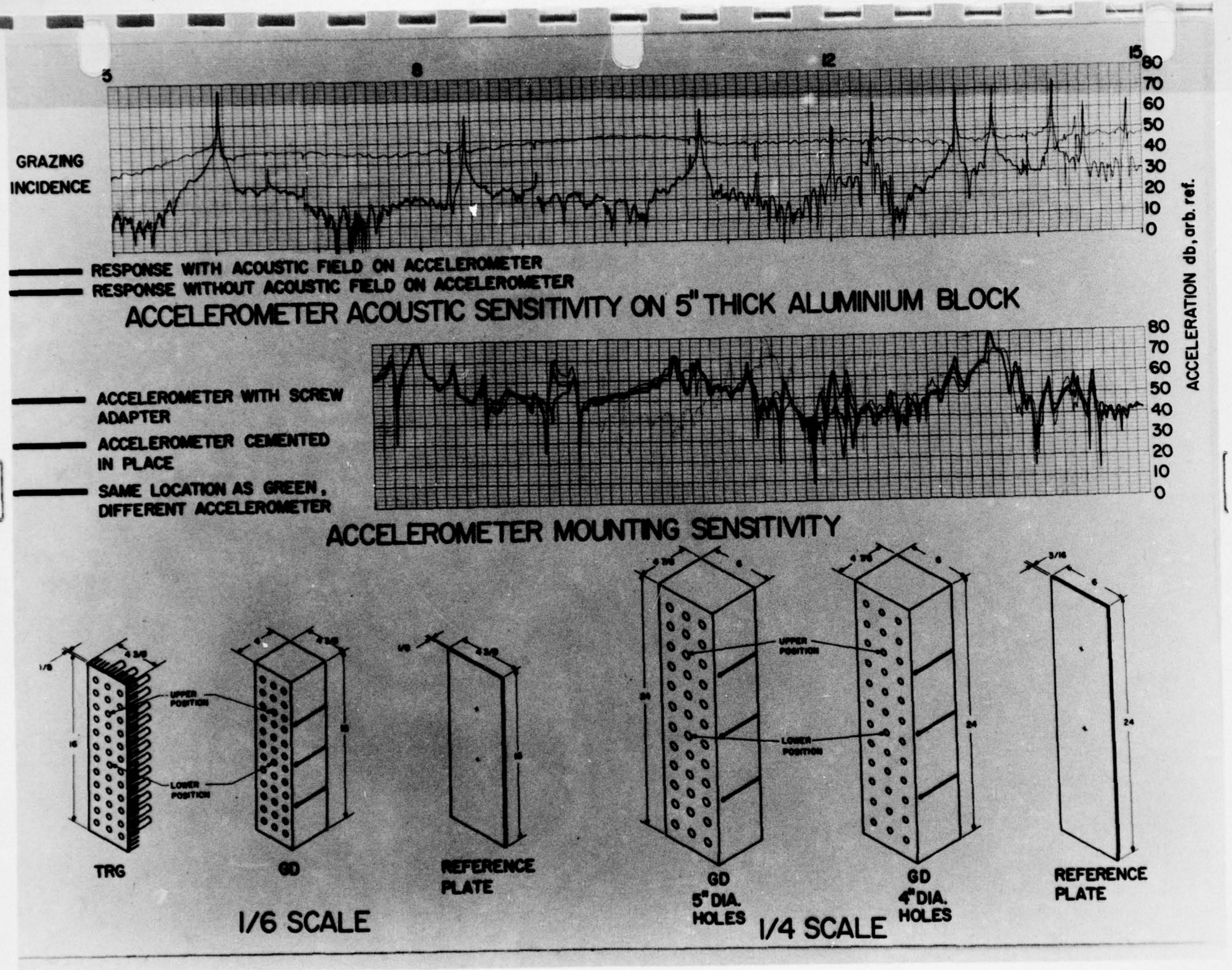
The benefit of changing the hole size from 5 inches (Plate 6) to 4 inches is evident. The frequency where the stiffening effect is lost was moved from 9.5 kc (2.37 kc full size) to 11 kc (2.75 kc, full size).

Figure 6

This plate shows the response of the 1/4 scale GD hull model with 5 inch holes compared to the reference plate. As previously mentioned in the description of Figure 4, the plate response above 9.5 kc (2.37 kc full size) was inadequate.

Comparison of this plate with Figure 3 shows the effect of changes in scale.

The prominent peak in the acceleration response at 14.4 kc in the 1/6 scale (2.4 kc full scale) in Figure 3 corresponds well with the prominent peak at 9.7 kc in the 1/4 scale (2.425 kc full scale) in Figure 6. However, the 1/6 scale model shows excessive acceleration below 14.4 kc as compared with the 1/4 scale. This suggests that the smaller the scale the less dependable, and probably the more pessimistic the result.



GRAZING
INCIDENCE
5
8
12
15
80
70
60
50
40
30
20
10
0
ACCELERATION db, arb. ref.
RESPONSE WITH ACOUSTIC FIELD ON ACCELEROMETER
RESPONSE WITHOUT ACOUSTIC FIELD ON ACCELEROMETER
ACCELEROMETER ACOUSTIC SENSITIVITY ON 5" THICK ALUMINIUM BLOCK
ACCELEROMETER WITH SCREW ADAPTER
ACCELEROMETER CEMENTED IN PLACE
SAME LOCATION AS GREEN, DIFFERENT ACCELEROMETER
ACCELEROMETER MOUNTING SENSITIVITY
UPPER POSITION
LOWER POSITION
TRG
GD
REFERENCE PLATE
1/6 SCALE
GD 5" DIA. HOLES
GD 4" DIA. HOLES
REFERENCE PLATE
1/4 SCALE
24
3/16

FIGURE 1

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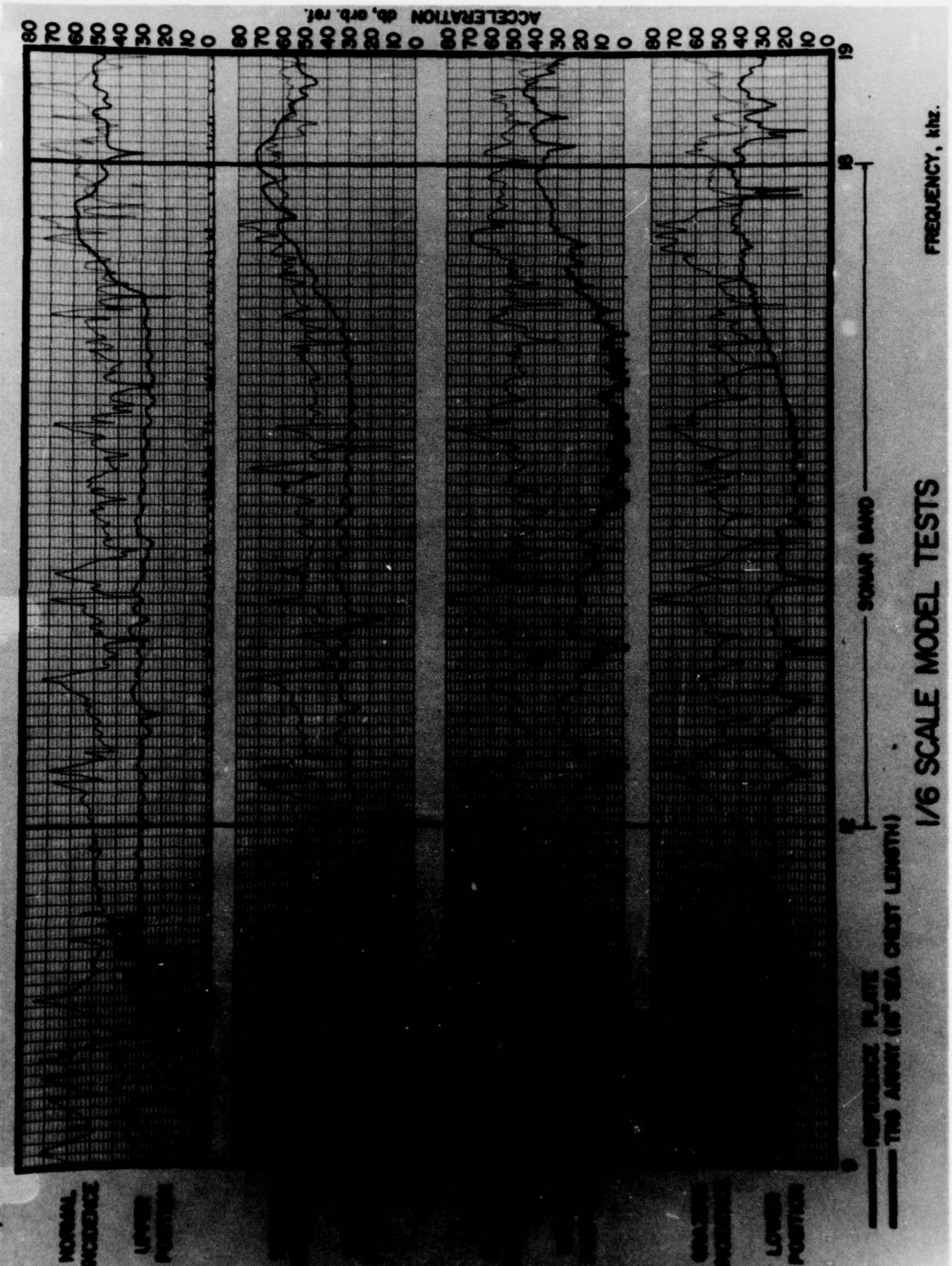

FIGURE 2

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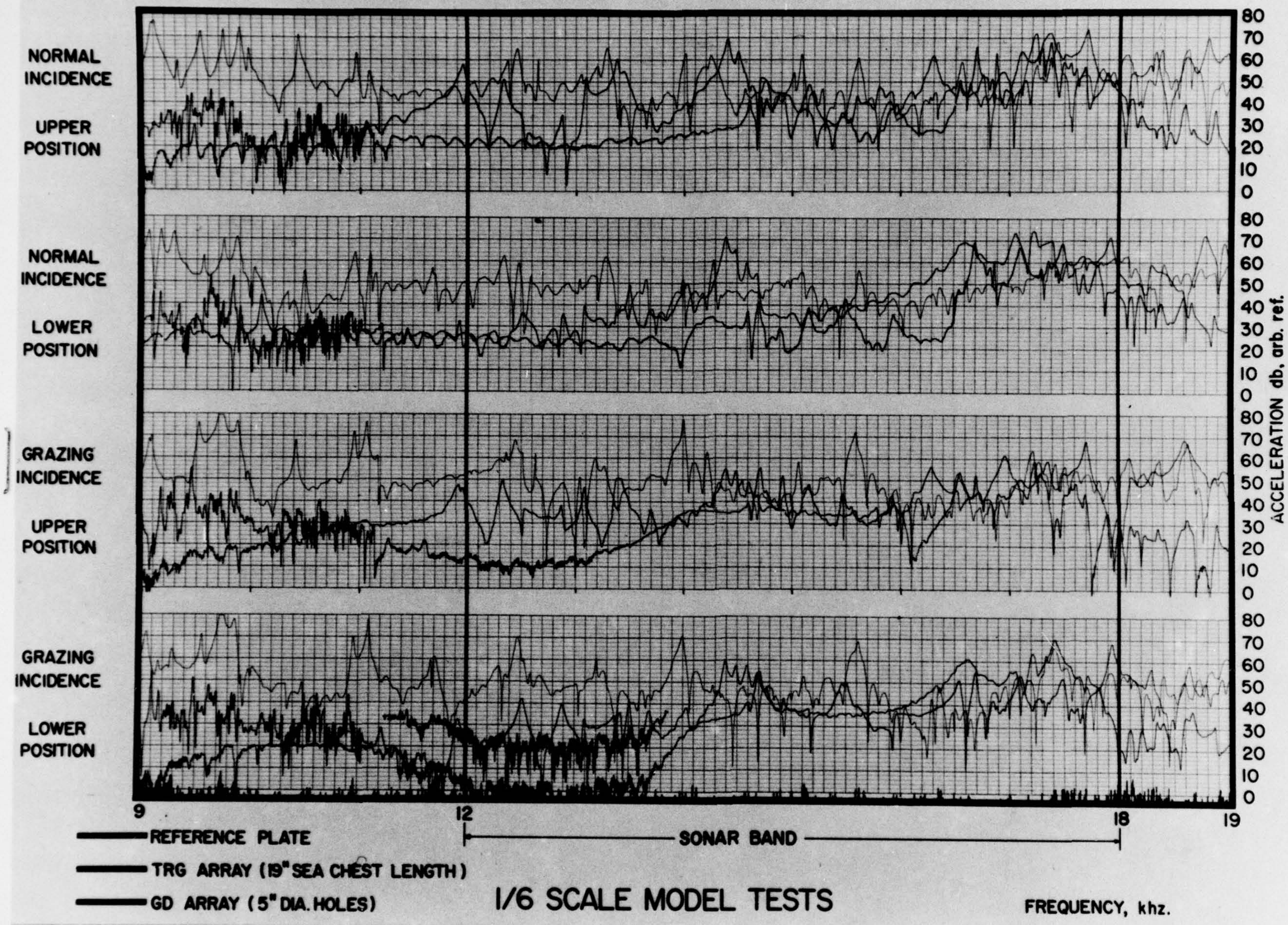
NORMAL INCIDENCE
UPPER POSITION
NORMAL INCIDENCE
LOWER POSITION
GRAZING INCIDENCE
UPPER POSITION
GRAZING INCIDENCE
LOWER POSITION
ACCELERATION db, arb. ref.
80
70
60
50
40
30
20
10
0
9
12
18
19
SONAR BAND
REFERENCE PLATE
TRG ARRAY (19" SEA CHEST LENGTH)
GD ARRAY (5" DIA. HOLES)
1/6 SCALE MODEL TESTS
FREQUENCY, khz.

FIGURE 3

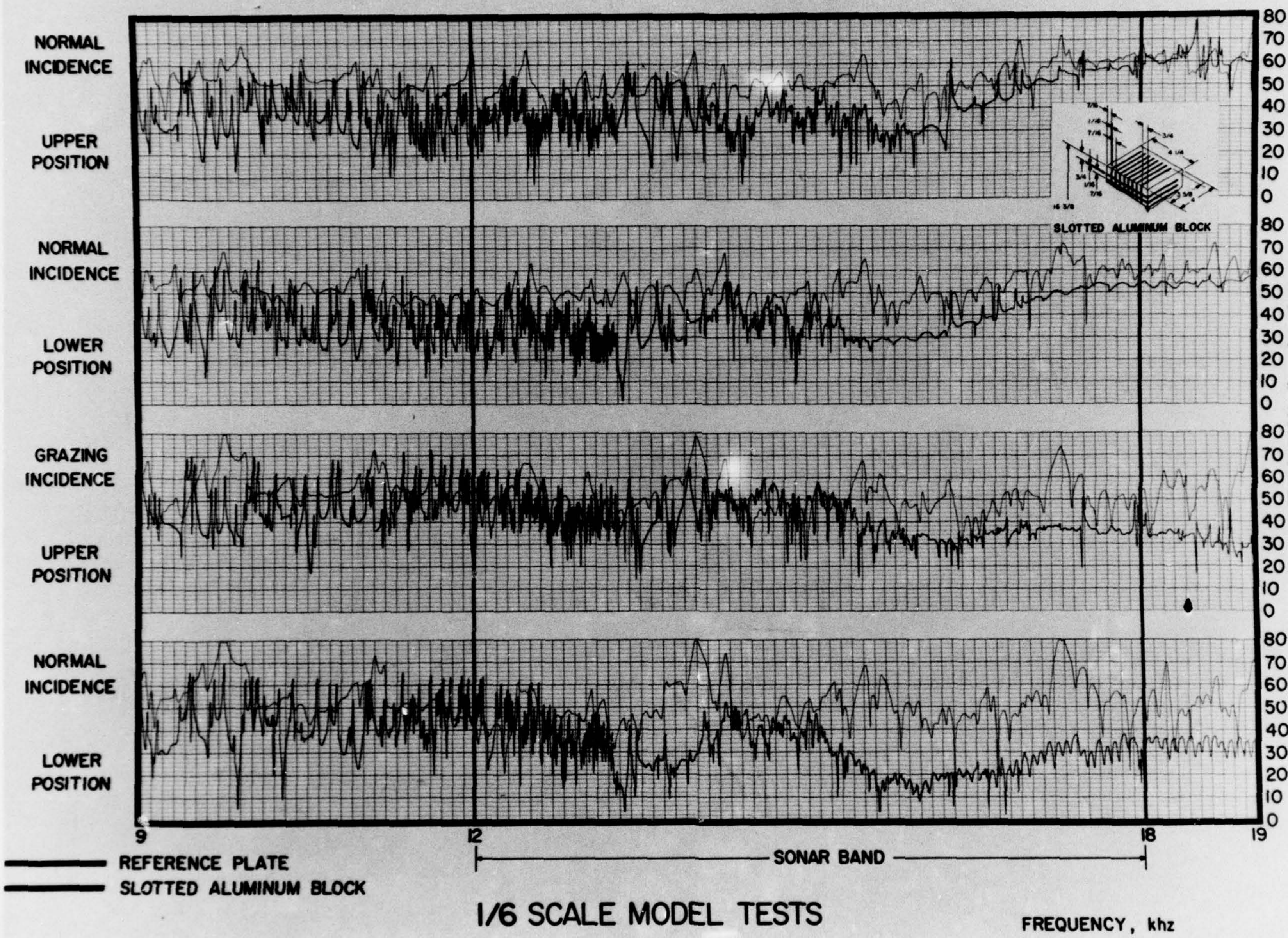
NORMAL INCIDENCE
UPPER POSITION
NORMAL INCIDENCE
LOWER POSITION
GRAZING INCIDENCE
UPPER POSITION
NORMAL INCIDENCE
LOWER POSITION
SLOTTED ALUMINUM BLOCK
ACCELERATION db, arb. ref.
80 70 60 50 40 30 20 10 0
9
12
18
19
SONAR BAND
REFERENCE PLATE
SLOTTED ALUMINUM BLOCK
1/6 SCALE MODEL TESTS
FREQUENCY, khz

FIGURE 4

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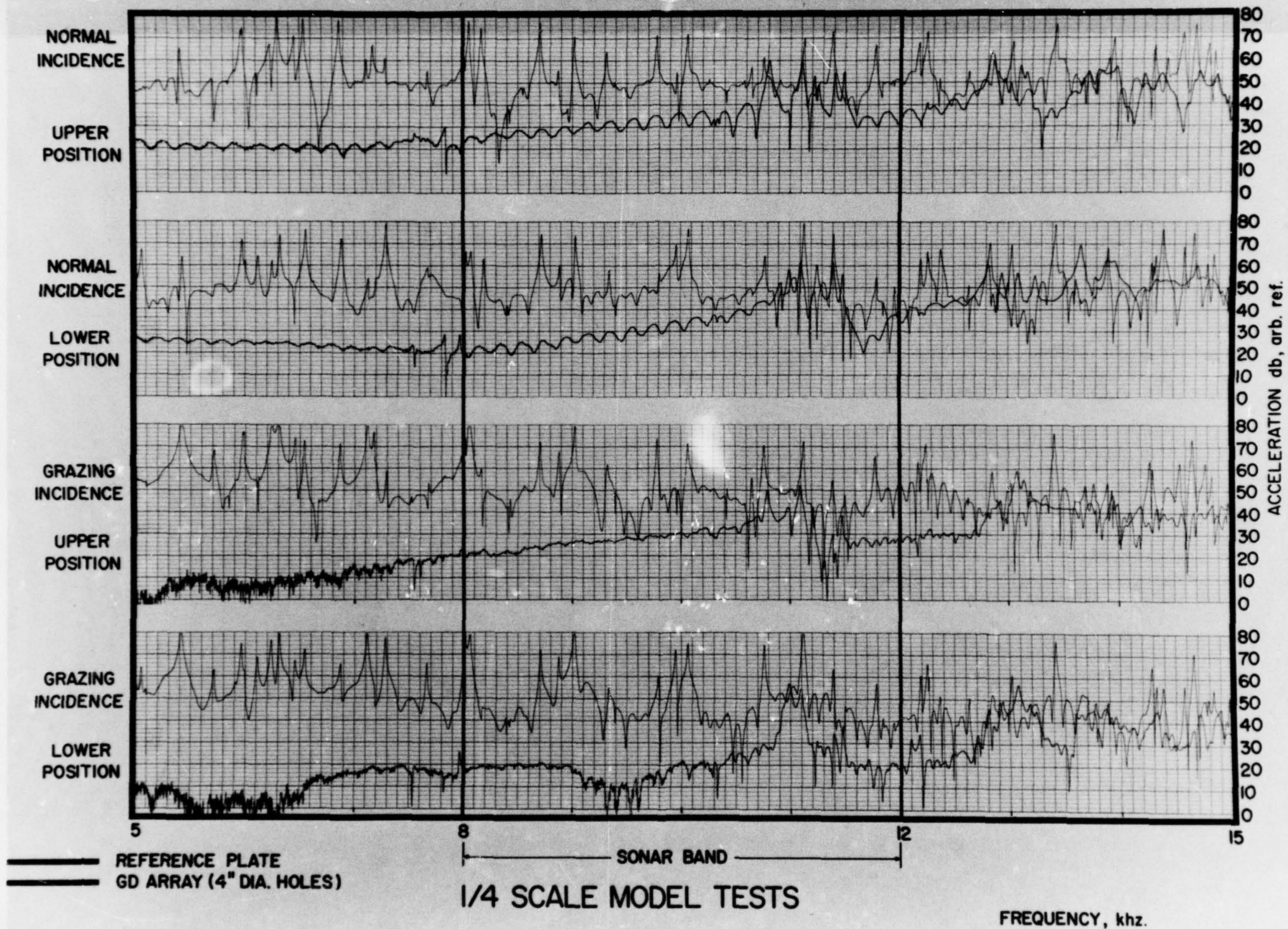

FIGURE 5

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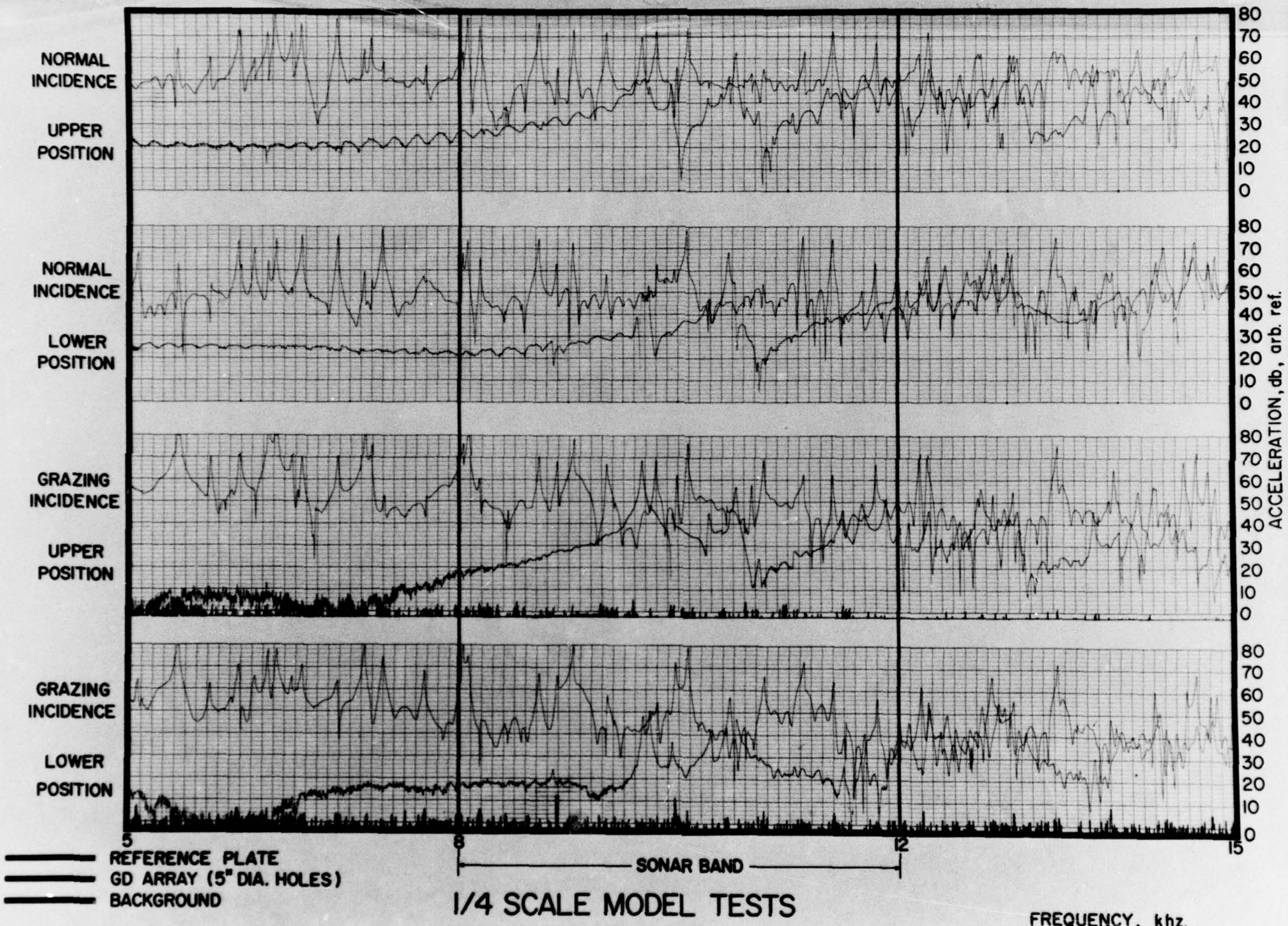
NORMAL INCIDENCE
UPPER POSITION
NORMAL INCIDENCE
LOWER POSITION
GRAZING INCIDENCE
UPPER POSITION
GRAZING INCIDENCE
LOWER POSITION
ACCELERATION, db, arb. ref.
80
70
60
50
40
30
20
10
0
5
8
12
15
SONAR BAND
REFERENCE PLATE
GD ARRAY (5" DIA. HOLES)
BACKGROUND
1/4 SCALE MODEL TESTS
FREQUENCY, khz.

FIGURE 6